NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Illinois No. 6 Underground Bituminous Coal Mine Site, Construction

Reference Flow: 1 piece (pcs) Illinois No. 6 Underground Bituminous Coal Mine Site

Brief Description: Construction materials for concrete structures and asphalt paving for an Illinois No. 6 coal mine site. Assumes concrete structures and paving are composed entirely of cement or asphalt, respectively.

Section I: Meta Data

Geographical Coverage: US **Region:** IL

Year Data Best Represents: 2007

Process Type: Basic Process (BP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: Individual Relevant Flows Recorded

Flows Aggregated in Data Set:

☒ Process ☐ Energy Use ☐ Energy P&D ☐ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☐ Greenhouse Gases	☐ Criteria Air Pollutants	☐ Other
Releases to Water:	☐ Inorganic Emissions	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

Tracked Input Flows:

Concrete, ready mix, R-5-0 [Concrete_Cement]	*Concrete used in mine construction; "R-5-0" indicates ready-mixed concrete, 100 percent Portland cement, 5,000 psi*

Asphalt [Construction materials]	*Road paving used in mine construction, consisting of 95 percent concrete and 5 percent bitumen.*

Tracked Output Flows:

Illinois No. 6 Underground Bituminous Coal Mine Site [Installation]	
	Construction of the Illinois No. 6 underground bituminous coal mine site (Reference flow)

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_C_CoalMineSite_I6_2010.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process covers the materials required for the construction of a coal mine site for the underground extraction of Illinois No. 6 (I-6) bituminous coal. The coal mine site includes asphalt-paved roads and concrete structures necessary to support the pathway of I-6 coal, within Life Cycle (LC) Stage #1. After coal is extracted and cleaned, it is transported by rail (LC Stage #2) to an energy conversion facility (LC Stage #3). This unit process is combined with other LC Stage #1 construction unit processes for the I-6 coal pathway under an assembly unit process, DF_Stage1_C_Assembly_I6_Coal_Underground_Mine_2010.01, which quantifies the fraction of coal mine site construction needed to produce 1 kg of I-6 bituminous coal.

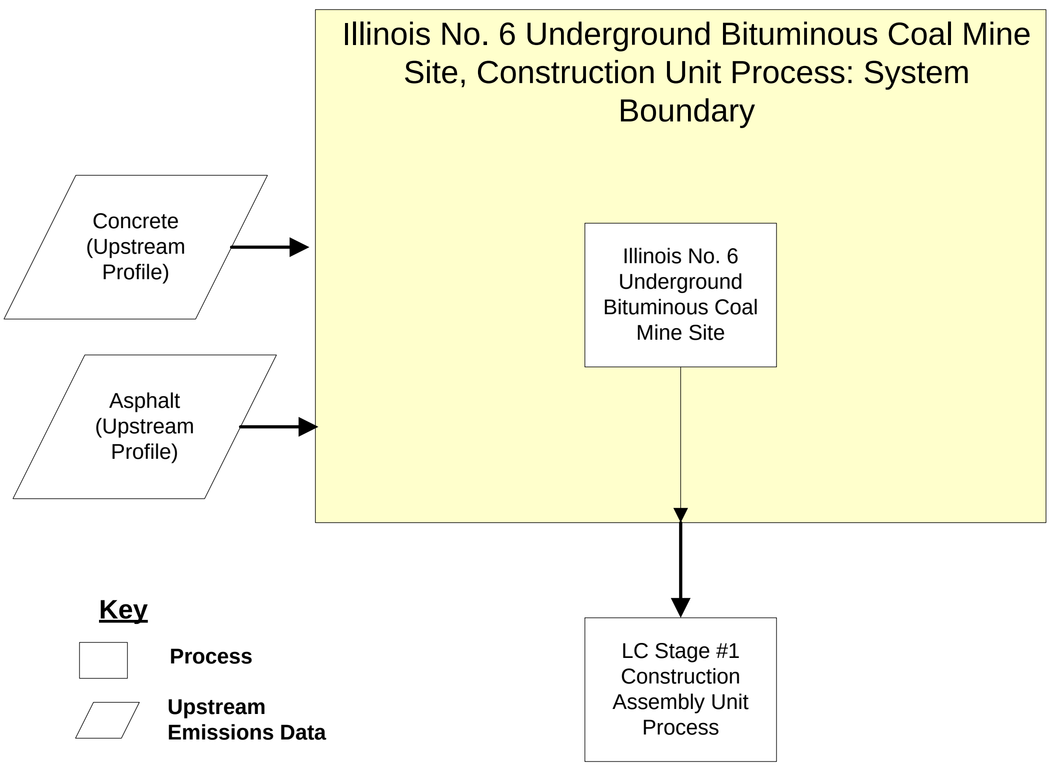
This unit process assumes that asphalt and concrete comprise the majority of construction materials necessary for the construction of a coal mine site and, therefore, does not account for other types of construction materials. Concrete and asphalt are produced upstream of the coal mine site. Therefore, the production of concrete and asphalt (and the resources and emissions associated with the production of concrete and asphalt) are outside the boundaries of this unit process. Mine commissioning (energy and emissions associated with installation of mine facilities at the mine site) and construction requirements of mine equipment and facilities, such as the wastewater treatment plant, mining machinery, storage equipment, and other equipment, are quantified in separate unit processes.

Boundary and Description

This unit process assumes that asphalt and concrete comprise all of the construction materials necessary for the construction of a mine site. The weights of asphalt and concrete were estimated for the Illinois No. 6 bituminous coal mine site based on the average developed acreage and material requirements of two mine applications in the State of Illinois. Applications from Sugarcamp Energy, LLC mine (Sugarcamp mine) in Macedonia, Illinois, and the Hillsboro Energy, LLC Deer Run Mine (Deer Run Mine) in Montgomery County, Illinois, were used as the primary references for this process (Hillsboro 2007; Sugar Camp 2007). These applications indicate the total developed acres, total paved road areas, and the dimensions of concrete structures required for a coal mine site. Note that the amount of materials used at each mine site depends upon an array of factors, including mine capacity as well as specific site characteristics such as topography. However, the two mines represent recently installed facilities that are similar in nature to the mine site that is considered for construction within this unit process.

Figure 1 provides an overview of the boundary of this unit process. Rectangular boxes represent relevant sub-processes, while trapezoidal boxes indicate upstream data that are outside of the boundary of this unit process. As shown, upstream emissions associated with the production and delivery of concrete and asphalt are calculated outside the boundary of this unit process, based on proprietary profiles available within the GaBi model. As shown in **Figure 1**, the Illinois No. 6 bituminous coal mine site constructed in this unit process is incorporated into the underground coal mine assembly process.

Figure 1: Unit Process Scope and Boundary



This unit process uses the developed land area of each mine site (e.g., Hillsboro, 2007; Sugar Camp, 2007) to develop material use factors (e.g., kg of concrete/developed hectare or kg of asphalt/developed hectare) for each mine site and, subsequently, material use factors that represent the study mine. The average developed land area of the Sugar Camp and Deer Run mines is 292 hectares (721 acres), which is thus the area of developed land assumed for the study mine. The calculation of the concrete and asphalt pavement requirements for the study mine is described below.

The concrete structures of this unit process include foundations, tanks, tubes (used for storage of coal near the coal stacker), and roofs at the mining sites. It is assumed that when the mine site applications (Sugar Camp 2007; Hillsboro 2007) express concrete use in terms of yards (yd), they imply an actual dimension of cubic yards (yd^3). The total cubic yards of concrete for each mine site was divided by the developed acres of each mine site to determine the relationship between concrete use and mine acreage. The average concrete use per developed acre is 10.9 m^3/hectare (5.7 yd^3/acre). This concrete use factor was applied to the developed acreage of the study mine and multiplied by the density of the concrete (Portland Cement 2008). The total mass of concrete used for the study mine is to 7,391,888 kg (16,296,323 lb).

This unit process assumes that mine roads are composed of a layer of asphalt applied on top of a concrete road base. The material composition of a paved road is 5 percent asphalt (as bitumen) and 95 percent concrete (this split between asphalt and concrete is accounted for in the "Asphalt [Construction materials]" input to this unit process). To determine the percentage of the study mine that is paved with roads, the road area reported by each mine site application (Sugar Camp 2007; Hillsboro 2007) was divided by the developed acreage of each mine site. On average, 4.71 percent of the mine sites are paved with roads. By applying this percentage to the total developed acreage of the study mine, the total area of paved roads is 14 hectares (34 acres). The thickness of the mine roads is 0.61 m (2 ft) (Hillsboro 2007; Sugar Camp 2007), which translates to a total volume of 83,912 m^3 (109,752 yd^3) of road paving material. This volume of road paving material was multiplied by the density of asphalt pavement (Papagiannakis 2006) to determine that the total weight of road pavement for the mine of this unit process is 198,934,060 kg (438,574,529 lb).

Table 1 summarizes the data sources and calculations used for this unit process.

Table 1: Materials for Mine Site Construction (Hillsboro 2007; Sugar Camp 2007)

Property	Value	Reference
Concrete Use		
Average Concrete Use, m^3 (yds^3)	2,977 (3,894)	Hillsboro 2007; Sugar Camp 2007
Average Developed Land Area, hectares (acres)	275 (685)	Hillsboro 2007; Sugar Camp 2007
Developed Land Area of Study Mine, hectares (acres)	292 (721)	NETL Engineering Calculation
Study Mine Concrete, m^3 (yd^3)	2,995 (3,918)	NETL Engineering Calculation
Concrete Density, kg/m^3 (lb/yd^3)	2,323 (3,915)	Portland Cement Association 2009
Study Mine Concrete, kg (lb)	6,957,144 (15,337,877)	NETL Engineering Calculation
Asphalt Use		
Average Asphalt Use, hectare (acres)	12.6 (31.0)	Hillsboro 2007; Sugar Camp 2007
Average Developed Land Area, hectares (acres)	275 (685)	Hillsboro 2007; Sugar Camp 2007
Asphalt Thickness, m (ft)	0.61 (2.0)	Hillsboro 2007; Sugar Camp 2007
Average Total Asphalt Use, m^3 (yd^3)	76,476 (100,027)	NETL Engineering Calculation
Developed Land Area of Study Mine, hectares (acres)	292 (721)	NETL Engineering Calculation
Study Mine Asphalt, hectares (acres)	14 (34)	NETL Engineering Calculation
Study Mine Asphalt, m^3 (yd^3)	78,968 (103,298)	NETL Engineering Calculation
Asphalt density, kg/m^3 (lbs/yd^3)	2,371 (3,996)	NETL Engineering Calculation
Study Mine Asphalt, kg (lb)	187,233,215 (412,778,581)	NETL Engineering Calculation

Table 2 provides a summary of modeled input and output flows. Additional details regarding input and output flows, including calculation methods, are contained in the associated DS.

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Concrete, ready mix, R-5-0 [Concrete_Cement]	**6,957,114**	**kg**
Asphalt [Construction materials]	**187,233,215**	**kg**
Outputs		
Illinois No. 6 Underground Bituminous Coal Mine Site [Construction]	1.00	pcs

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows. Upstream environmental flows were added during the modeling process using GaBi modeling software, as shown in Figure 1.

Embedded Unit Processes

None.

References

Hillsboro Energy, LLC 2007	Hillsboro Energy, LLC. 2007. *Applications for Underground Mine Permits, #399*. http://dnr.state.il.us/mines/lrd/applications.htm (Accessed December 14, 2009).
Papagiannakis 2006	Papagiannakis, A.T., Bracher, M., Li, J., Jackson, N. 2006. *Pavement: Appendix C. Structural and Climatic Input, Structure Asphalt Concrete Pavement.* U.S. Department of Transportation, Federal Highway Administration. FHWA-HRT-05-079. http://www.fhwa.dot.gov/pavement/ltpp/pubs/05079/appc.cfm#toc132080751 (Accessed December 14, 2009).
Portland Cement Association 2009	Portland Cement Association. 2009. *Concrete Technology: Frequently Asked Questions.* Portland Cement Association. http://www.cement.org/tech/faq_unit_weights.asp (Accessed December 14, 2009).
Sugar Camp Energy, LLC 2007	Sugar Camp Energy, LLC. 2007. *Applications for Underground Mine Permits, #382.* Illinois Department of Natural Resources. http://dnr.state.il.us/mines/lrd/applications.htm (Accessed October 8, 2008).

Section III: Document Control Information

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Revision History:

Original/no revisions

How to Cite This Document: This document should be cited as:

NETL (2010). NETL Life Cycle Inventory Data – Process Documentation File: Illinois No. 6 Underground Bituminous Coal Mine Site Construction. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: October 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

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